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(71)Applicant : SONY CORP

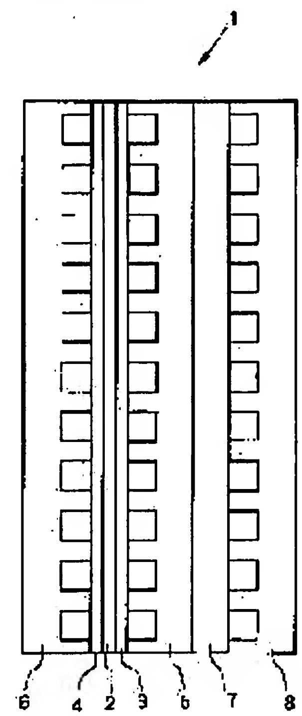
(72)Inventor : SHIRAI KATSUYA

(54) SOLID POLYMER ELECTROLYTE FUEL CELL AND FUEL CELL STACK

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a fuel cell of high energy utilization efficiency by utilizing thermal energy as well generated by electrochemical reaction.

SOLUTION: The solid polymer electrolyte fuel cell 1 is provided with a solid polymer electrolyte film 2, an oxygen electrode 3 and a fuel electrode 4 pinching the solid polymer electrolyte film 2, a field plate 5 on the oxygen electrode side contacting a side face opposite to the one facing the solid polymer electrolyte film 2 of the oxygen electrode 3, a field plate 6 at the fuel electrode side contacting a side face of opposite to the one facing the solid polymer electrolyte film 2 of the fuel electrode 4, a thermoelectric conversion element contacting a side face opposite to the one facing the oxygen electrode 3 of the field plate 5 side, and a field plate 8 for coolant contacting a side face opposite to the one facing the oxygen electrode side field plate 5 of the thermoelectric conversion element 7.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the fuel cell stack which made stack structure the solid-state polyelectrolyte mold fuel cell and this fuel cell which have a thermoelectric element inside.
[0002]
[Description of the Prior Art] Electrical energy is used for a fuel cell among the electrical energy and heat energy which are generated according to the electrochemical reaction which generates water from hydrogen and oxygen, and a solid-state polyelectrolyte mold fuel cell (henceforth a "fuel cell") is a fuel cell using the solid-state polyelectrolyte film (henceforth the "proton conduction film") of proton conductivity. Power can be taken out by arranging the two electrodes of a negative electrode (fuel electrode) and a positive electrode (an oxygen pole or air pole) on both sides of the proton conduction film, supplying the hydrogen gas as a fuel etc. to a negative-electrode side, supplying air or oxygen to a positive-electrode side, and making electrochemical reaction cause.
[0003]
[Problem(s) to be Solved by the Invention] However, in a fuel cell, a part is changed also into heat energy and it the supplied fuel is not only changed into electrical energy, but is accompanied by the phenomenon in which a negative electrode generates heat in connection with electrochemical reaction. In the conventional fuel cell, there is no attempt which is going to use this heat energy positively, and the limitation was in the use effectiveness of energy.
[0004] Then, this invention aims at positive use of the heat energy with which the conventional use was not presented among the energy generated according to electrochemical reaction, and aims at offer of the fuel cell which raised the use effectiveness of energy.
[0005]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the solid-state polyelectrolyte film of proton conductivity [this invention], The fuel electrode side field plate with which the gas passageway for the fuel electrode and oxygen electrode which pinch this solid-state polyelectrolyte film, and the solid-state polyelectrolyte film pinching side of this fuel electrode being allotted to an opposite side side, and supplying fuel gas to this fuel electrode was formed, In the solid-state polyelectrolyte mold fuel cell which consists of an oxygen pole side field plate with which the gas passageway for the solid-state polyelectrolyte film pinching side of this oxygen electrode being matched for an opposite side side, and supplying oxygen gas to this oxygen electrode was formed It combines with this fuel electrode side field plate or this oxygen pole side field plate, and the solid-state polyelectrolyte mold fuel cell equipped with the thermoelectric element which transforms into electrical energy the heat energy taken out from this oxygen electrode is offered.
[0006] Moreover, it is good also as a fuel cell stack of the structure to which the thermal break was made to be placed between and the laminating of two or more generation-of-electrical-energy cels was carried out by using the fuel cell of such a configuration as a generation-of-electrical-energy cel.
[0007] In the solid-state polyelectrolyte mold fuel cell or fuel cell stack of this configuration, fuel gas, such as hydrogen gas, is supplied to a fuel electrode through a fuel electrode side field plate. In a fuel electrode, the hydrogen in fuel gas ionizes and an electron and a proton (H+) arise. An electron is emitted to a fuel electrode and a proton is supplied to an oxygen electrode through the solid-state polyelectrolyte film.
[0008] The load is connected between the fuel electrode side field plate and the oxygen pole side field plate, and the electron emitted to the fuel electrode flows into an oxygen electrode through this load.
[0009] In an oxygen electrode, while this electron, the proton supplied through the solid-state polyelectrolyte film, and the oxygen gas further supplied through the oxygen pole side field plate generate a lifting and water for electrochemical reaction, the temperature rise of an oxygen electrode is brought about. In connection with

the temperature rise of an oxygen electrode, the temperature of an oxygen pole side field plate and a fuel electrode side field plate also rises. One field is combined with an oxygen pole side field plate or a fuel electrode side field plate, the thermoelectric element serves as an elevated temperature, and the temperature of the field of another side is kept low. Consequently, the electromotive force of alphaxdelta T occurs by temperature-gradient deltaT by the side of the elevated temperature of a thermoelectric element, and low temperature, and Seebeck coefficient alpha of a thermoelectric element. In this way, the heat energy it not only supplies and uses for a load the electrical energy generated according to the electrochemical reaction of hydrogen and oxygen, but generated in connection with the electrochemical reaction concerned can also be used as electrical energy of another network.

[0010] You may make it combine with this thermoelectric element the field plate for cooling with which the gas passageway for supplying a cooling agent was formed. This invention offers the fuel cell stack of the structure to which the thermal break was made to be placed between and the laminating of two or more generation-of-electrical-energy cels was carried out by using the fuel cell of a configuration of having had such a field plate for cooling again as a generation-of-electrical-energy cel.

[0011] According to such a fuel cell or the fuel cell stack, the temperature by the side of the low temperature of a thermoelectric element is kept low, and efficient thermoelectrical conversion can be performed.

[0012] Here, it is desirable to use air or water as a cooling agent. This invention offers the fuel cell stack of the structure to which the thermal break was made to be placed between and the laminating of two or more generation-of-electrical-energy cels was carried out by using as a generation-of-electrical-energy cel the fuel cell of a configuration of having had the field plate for cooling which used air or water as a cooling agent again.

[0013] According to such a fuel cell or the fuel cell stack, supply of a cooling agent is easy and can hold down cost low.

[0014]

[Embodiment of the Invention] The fuel cell by the gestalt of operation of this invention is explained based on drawing 1 and drawing 2 .

[0015] As shown in drawing 1 , the fuel cell 1 concerning the gestalt of this operation The proton conduction film 2, and the oxygen electrode 3 and the fuel electrode 4 which pinches the proton conduction film 2, The oxygen pole side field plate 5 arranged on the outside of an oxygen electrode 3 and the fuel electrode 4, respectively, and the fuel electrode side field plate 6, With the side which faces the oxygen electrode 3 of the oxygen pole side field plate 5, the thermoelectric element 7 which touches an opposite side side, and the side which faces the oxygen pole side field plate 5 of a thermoelectric element 7 consist of field plates 8 for cooling agents which touch an opposite side side. A thermoelectric element 7 and the part except the field plate 8 for cooling agents are the same configurations as the conventional fuel cell among the fuel cells of this configuration, and the description of the gestalt of this operation is that it added the thermoelectric element 7 and the field plate 8 for cooling agents to the conventional fuel cell. Although not illustrated, at the time of use, a load is connected between the oxygen pole side field plate 5 and the fuel electrode side field plate 6.

[0016] With the gestalt of this operation, the film made in the Pori hydroxylation fullerene (a common name, FURARE Norian) is used as proton conduction film 2. Since the film formed by the Pori hydroxylation fullerene is excellent in membrane formation nature etc. compared with what was formed with perfluoro sulfonic acid type resin and does not need mediation of a water molecule for conduction of a proton (H+), there is an advantage, like a humidifier etc. is unnecessary and an operating-temperature field is still as larger as -40 degrees C - 160 degrees C.

[0017] The gas passageway for the gas passageway for supplying oxygen gas (air) to an oxygen electrode 3 to supply fuel gas slack hydrogen to the field side which similarly contacts the fuel electrode 4 of the fuel electrode side field plate 6 at the fuel electrode 4 is formed at the field side in contact with the oxygen electrode 3 of the oxygen pole side field plate 5. The passage for supplying the cooling agent for cooling a thermoelectric element 7 also to the field side in contact with the thermoelectric element 7 of the field plate 8 for cooling agents is formed. Water, air, etc. are used as a cooling agent.

[0018] The detailed configuration of a thermoelectric element 7 is shown in drawing 2 . Drawing 2 is a sectional view when disconnecting perpendicularly the fuel cell shown in drawing 1 to space. As illustration, a cross section is the same with p type semiconductor 7A of a L character configuration, and a cross section has n-type-semiconductor 7B of a L character configuration, makes each L character configuration leg contact, and constitutes a thermoelectric element 7. Terminal 7C and terminal 7D are joined to the watch section of p type semiconductor 7A and n-type-semiconductor 7B, respectively. The near field where p type semiconductor 7A and n-type-semiconductor 7B were joined is in contact with the oxygen pole side field plate 5. Moreover, both terminal 7C and terminal 7D are in contact with the field plate 8 for cooling agents.

[0019] With the gestalt of this operation, Bi80Sb12 of Bi2Te3 system was used as an ingredient of n-type-semiconductor 7B using the material which consists of Bi2Te355% and Sb2Te245% of Bi2Te3 system as an ingredient of p type semiconductor 7A. In addition, the thermoelectrical conversion ingredient of CoAs3 and CoSb3 of a SUKUTTERUDAITO system, and IrSb3 grade is suitable as an ingredient of a p type semiconductor, and the thermoelectrical conversion ingredient of Bi2Te380% and Sb2Te320% of Be2Te3 system is suitable as an ingredient of a n-type semiconductor. Moreover, the thermoelectrical conversion ingredient of the oxidation system of SnO2, ReO3, and MgIn2O4 grade can be used also as a which ingredient of a p type semiconductor and a n-type semiconductor by changing a dopant.
[0020] Next, actuation of the fuel cell 1 of the gestalt of this operation is explained.
[0021] First, oxygen gas is supplied to an oxygen electrode 3 through the oxygen pole side field plate 5, and hydrogen gas is supplied to the fuel electrode 4 through the fuel electrode side field plate 6. If hydrogen gas is supplied to the fuel electrode 4, while hydrogen will be ionized in an operation of the catalyst included in the fuel electrode 4 and an electron will be emitted to the fuel electrode 4, a proton is supplied to an oxygen electrode 3 through the proton conduction film 2.
[0022] In an oxygen electrode 3, a proton, oxygen, and the electron that reached through the fuel electrode side field plate 6 and the load from the fuel electrode 4 further cause the electrochemical reaction accompanied by generation of heat. In connection with such electrochemical reaction, a current flows for a load and electrical energy is consumed in a load. On the other hand, an oxygen electrode 3 generates heat in the case of this electrochemical reaction, that heat is transmitted to the oxygen pole side field plate 5, and the temperature of the oxygen pole side field plate 5 rises. The temperature in the plane of composition of p type semiconductor 7A located in the field which touches the oxygen pole side field plate 5 of a thermoelectric element 7 by this, and n-type-semiconductor 7B rises.
[0023] Terminal 7C and terminal 7D which touch the field plate 8 for cooling agents of a thermoelectric element 7 are cooled with the cooling agent supplied with the field plate 8 for cooling agents, and temperature is kept low. Consequently, the contact surface with the oxygen pole side field plate 5 becomes an elevated-temperature side, the field cooled with the field plate 8 for cooling agents becomes a low temperature side, and the electromotive force of alphaxdelta T generates a thermoelectric element 7 by temperature-gradient deltaT by the side of an elevated temperature and low temperature, and Seebeck coefficient alpha of a thermoelectric element 7.
[0024] Thus, the electromotive force acquired by the thermoelectric element 7 is 20mV thru/or about 60mV in the case where Bi2Te3 and Bi2Se3 are used as n-type-semiconductor7B, using Bi2Te3 and Sb2Te3 as p type semiconductor7A, when the temperature gradient between the oxygen pole side field plate 5 and the field plate 8 for cooling agents is made into about 100 degrees C.
[0025] The electromotive force produced in a thermoelectric element 7 can be used as a power source for value monitors to which the value monitor of the condition of a system is carried out, or can be used as a power source for driving LED.
[0026] Next, the fuel cell stack by the gestalt of operation of this invention is explained based on drawing 3 .
[0027] The fuel cell stack 10 of the gestalt of this operation makes stack structure this generation-of-electrical-energy cel, using the fuel cell shown in drawing 1 as a generation-of-electrical-energy cel. That is, it is the side which faces the thermoelectric element 7 of the field plate 8 for cooling agents of the generation-of-electrical-energy cel 1 with the configuration of having allotted the thermal break 9 to the opposite side side, and having allotted still more nearly another generation-of-electrical-energy cel 1 to the opposite side side of a thermal break 9. The thermal break 9 was formed between two generation-of-electrical-energy cels 1 for preventing that the heat generated with the oxygen electrode 3 of one generation-of-electrical-energy cel 1 conducts to the field plate 8 for cooling agents of the generation-of-electrical-energy cel 1 of another side, and the temperature gradient between the field plate 8 for cooling agents of the generation-of-electrical-energy cel 1 of this another side and the oxygen pole side field plate 5 becomes small.
[0028] The deformation and amelioration various in the range which it was not limited to the gestalt of operation mentioned above, but were indicated to the claim are possible for the fuel cell and fuel cell stack by this invention.
[0029] For example, although the thermoelectric element was prepared in the opposite side side in the fuel cell of the gestalt of the above-mentioned implementation with the side which faces the oxygen electrode of an oxygen pole side field plate, with the side which faces the fuel electrode of a fuel electrode side field plate, you may prepare in an opposite side side. It is because the heat generated with the oxygen electrode transmits also to a fuel electrode and a fuel electrode also has a temperature rise to some extent. However, it is an oxygen electrode side that the electrochemical reaction of a proton and oxygen occurs, and it cannot be overemphasized that waste heat can be used that the direction of an oxygen pole side field plate prepared the thermoelectric

element in the oxygen pole side field plate side efficiently [direction] like the gestalt of the above-mentioned implementation since temperature was higher than a fuel electrode side field plate.

[0030] Moreover, although the field plate for cooling has been arranged in the fuel cell of the gestalt of the above-mentioned implementation in order to keep high the temperature gradient by the side of the elevated temperature of a thermoelectric element, and low temperature, you may make it maintain the low temperature side of a thermoelectric element at a room temperature not using the field plate for cooling.

[0031] Moreover, in the fuel cell of the gestalt of the above-mentioned implementation, although the film formed by the Pori hydroxylation fullerene was used in the condition of not humidifying, as proton conduction film in which proton conduction is possible, this invention is not limited to this. Although the Pori hydroxylation fullerene uses a fullerene molecule as shown in drawing 4 as a parent and introduces a hydroxyl group into the configuration carbon atom, it should just be a carbonaceous ingredient which uses not only a fullerene molecule but carbon as a principal component as a parent. A carbon atom does not ask this carbonaceous ingredient about the class of association between carbon-carbon, but the carbon cluster which is the aggregate which joins together hundreds of pieces and is formed from some, and tube-like carbonaceous (common-name carbon nanotube) may be included in it. in the former carbon cluster, the various carbon clusters (drawing 5) which have the solid sphere to which many carbon atoms come to gather, prolate spheroid, or the closed plane structure similar to these, and a part of those ball structures suffer a loss, and the carbon cluster (drawing 7) to which the carbon atom of the carbon cluster (drawing 6) most which has an open end has the diamond structure combined SP3 in structure, and the carbon cluster (drawing 8) which these clusters boiled variously and they combined further may be contained in it.

[0032] Moreover, as a radical introduced into this kind of parent, what is necessary is just a radical not only a hydroxyl group but -XH and proton dissociative [which are more preferably expressed with -YOH]. X and Y are the atoms or atomic groups of the arbitration which has a divalent joint hand here, H is a hydrogen atom and O is an oxygen atom. Specifically, it is desirable to sulfuric-acid hydrogen ester group-OSO3H, carboxyl group-COOH, and others that it is -SO3H or -OPO (OH)2 in addition to the aforementioned -OH.

[0033] By any above-mentioned modification, it is unnecessary in humidification to conduction of a proton, and there is no change in the effectiveness in this invention.

[0034] Moreover, although shown as a gestalt of operation of the fuel cell stack which consists of two generation-of-electrical-energy cels of the gestalt of the above-mentioned implementation, the number of the generation-of-electrical-energy cels made into stack structure may be not only two but three or more. In this case, it is desirable to prepare a thermal break between each generation-of-electrical-energy cel, respectively.

[0035]

[Effect of the Invention] Since the thermoelectric element which transforms heat energy into electrical energy was combined with either the oxygen pole side field plate or the fuel electrode side field plate according to claim 1, the solid-state polyelectrolyte mold fuel cell according to claim 4, and the fuel cell stack, not only the electrical energy generated according to the electrochemical reaction of hydrogen and oxygen but the electrical energy obtained by carrying out thermoelectrical conversion of the heat energy generated according to the electrochemical reaction concerned can be used, and the generating efficiency of the whole fuel cell improves.

[0036] Since the field plate for cooling with which the gas passageway for supplying a cooling agent was formed was combined with the thermoelectric element according to claim 2, the solid-state polyelectrolyte mold fuel cell according to claim 5, and the fuel cell stack, the temperature gradient of a thermoelectric element can be kept large and thermoelectrical conversion can be performed efficiently.

[0037] According to claim 3, a solid-state polyelectrolyte mold fuel cell according to claim 6, and the fuel cell stack, since air or water was used as a cooling agent, supply of a cooling agent is easy and can hold down cost low.

[Translation done.]

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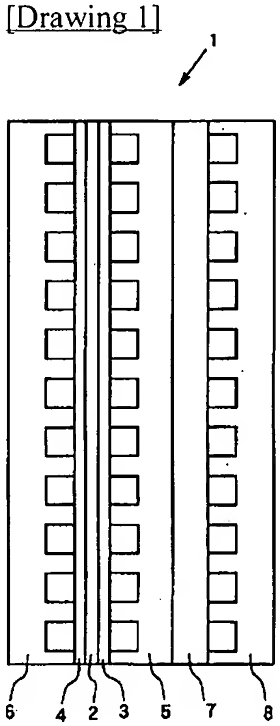
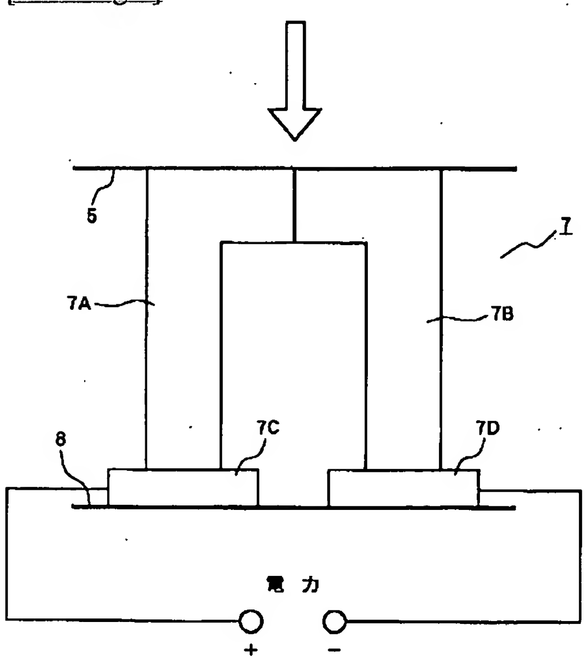
DRAWINGS

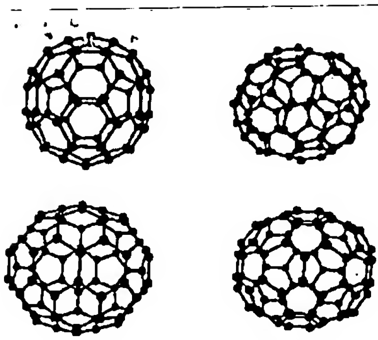
[Drawing 1]



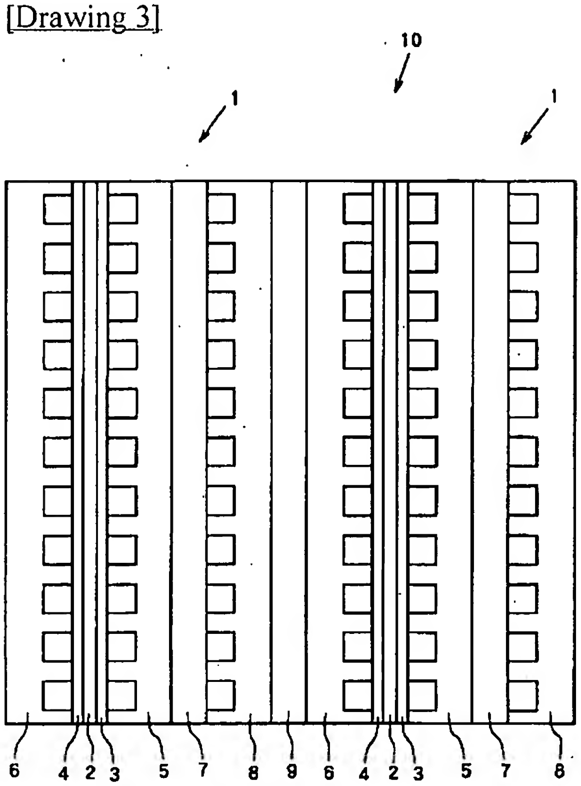
[Drawing 2]



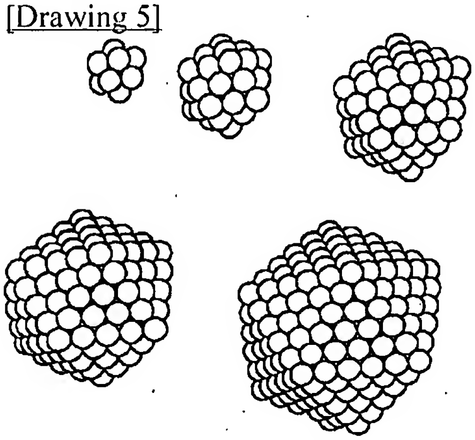
[Drawing 4]



[Drawing 3]



[Drawing 5]



[Drawing 6]